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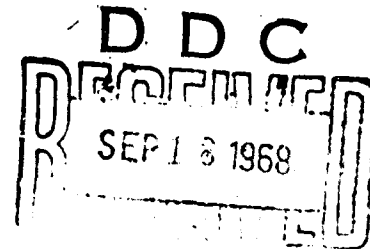
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DEPARTMENT OF THE ARMY
Fort Detrick
Frederick, Maryland

THE EXCRETION OF URINE COMPONENTS DURING FEVER ATTACKS

Virchow's Archiv.
Vol 155, 1899, pp 1-43

W. Von Morawski

It is one of the most well-known facts that during fever the N-excretion is increased, whereas chlorine is retained by the body. Phosphates and potassium salts are to be added to nitrogen, and sodium salts are to be added to chlorine. The most beautiful and the best studies have led to these results; for instance, the research of Traube and Jochmann (1), Redtenbacher (2), Ringer (3), Brattler (4), Harthausen (5), Rosenstein (6) Riesenfeld (7), Unruh (8), Huppert (9), Schleich (10), E. Hallervorden (11), Salkowsky (12), Naunyn (13, 14), Zulzer (15) Rohmann (16), v. Limbeck (17), Senator (18), v. Terrey (19), Liebschmeister (20), Leyden (21), S. Rem Pirel and v. Calcini (22), and many others. In the oldest works by Moos, Uhle, Ranks, Wasmuth, Bartels, and in the above-mentioned works which are not complete by far, rules are formulated, in most cases, on the basis of a longer observation period, an observation running for days and not for hours (with the exception of the work by Naunyn). The experimental material which included almost all urine components provided therefore a characteristic for the stage of the fever rather than for the beginning and the end of the fever.

Only the most recent observations made in the "shortened" fever -- malaria -- provided new and surprising facts. Also the present experiment has been stimulated by the work of my colleague and friend Dr. Theodor Hitzig. The abnormal behavior of the chlorides and of phosphorus in the case of malaria which is in great contrast to the findings of the fever metabolism (v. Limbeck, Terrey) drew my attention to other types of fevers and stimulated me to repeat the old observations and to carry out independent experiments. To be sure, it had also been observed by the previous workers that there is an increase in N-elimination after the fever (Naunyn) or that there is a tremendous drop in the elimination of potassium salts after the fever (Salkowsky), or that ammonia is eliminated in increased amounts during the fever and is even more strongly eliminated after the fever (Hallervorden). There was also sometimes an increase in the retention of chlorides after a fever (Ringer), as well as an increase in phosphoric acid (v. Harthausen) in the urine.

This all was known and our work cannot contribute many new data. In our work, the types of fevers are compared with respect to the behavior of the salts prior to, during, and after the fever, the results are summarized and interpreted from that point of view which, on the basis of the previous observations, appears to be most appropriate.

The material comes from the clinic of Professor Dr. Hermann Eichhorst and I am indebted to him for his cooperation and continuous support; I am also grateful to his assistant Dr. Th. Hitsig in whose department the patients were located and whose friendly cooperation has contributed much to the completion of this work.

The chemical methods which I have used have been frequently described in my earlier papers and I can limit myself to refer to these papers (Virchow's Archiv, Vols 146, 150, et cetera, Zeitschrift für klinische Medizin, Vols 34, 35).

The determination of potassium and sodium was carried out according to Fresenius' well-known method: fusion of 50 cc urine with ammonium sulfate to transform potassium and sodium into the non-volatile sulfates, treatment of the fusion residue with barium chloride and barium hydrate to obtain sodium and potassium chlorides, removal of the excess barium with ammonium carbonate, driving off of the excess ammonium salts, and weighing of the residue as sodium chloride and potassium chloride in a platinum crucible.

Potassium was subsequently precipitated with platinum chloride from the residue, washed with alcohol and ether, dissolved in boiling water, the solution evaporated, and the residue weighed as potassium platinum chloride.

The amount of sodium was calculated from the found amount of potassium by subtracting the potassium chloride from the sum of both chlorides.

Chlorine was determined according to the Volhard method, phosphorus and calcium according to Neubauer, urea according to Mörner, uric acid according to Ludwig-Salkowsky, ammonia according to Schlösing, the alloxuric bases according to the method which I have described in Virchow's Archiv, Vol 150*.

The same holds for the diet and the determination of the nutrition value of the food. The food analyses which Th. Hitsig carried out for his work confirmed our previous studies, and they provide sufficient assurance for uniform preparation of the food, as well as for reliability of the methods.

The patients were under reliable supervision and were, if necessary, instructed by us so that the examination which has to be done with extreme

* The new work of Salkowsky in Pfäfliger's Archiv 1898 was not yet known.

care was simplified. For instance, the separation of the urine from the feces was always very carefully observed; also, punctual emptying of the bladder was emphasized. The temperature was measured by experienced nurses.

We observed two cases of Febris continua with a gradual increase and a gradual decrease in temperature (typhus), one case of a fever involving a crisis (pneumonia), one case of malaria fever, and one case of hectic fever. We did not study other types of fevers during acute exanthemas, articular rheumatism, et cetera because it had been determined by earlier observations that such cases give less clear-cut results and are subject to individual fluctuations.

To obtain as clear a picture as possible, we have carried out urina determinations, the determination of the total nitrogen, of uric acid, of xanthine bases, [and] of ammonia. In addition, the chlorides, phosphates, potassium, sodium, and calcium were determined.

In the pneumonia case, the urine was collected until the crisis and after the crisis; in the case of the malaric fever, five portions were collected which corresponded 1) to the cold stage, 2) to the climax of the fever, 3) to the remission, 4) to the additional drop in the fever, [and] 5) to the apyrexia. In the case of Febris hectica, four portions corresponding to the stages 1) of the beginning fever, 2) of the climax of the fever, 3) of the remission, 4) of the apyrexia were collected. In the case of typhus I, the urine was collected as daytime urine and nighttime urine during three periods: 1) the climax of the fever, 2) the paracme, [and] 3) the afebrile period. In the case of typhus II, the entire amount of 24 hours was examined, without interruption of the entire course comprising the periods 1) of the increase, 2) of the continuous fever, [and] 3) of the apyrexia. Details will be discussed in each individual case.

The compilation of the tables differed, depending on the cases. The hourly amounts were emphasized in the cases of malaria and hectic fever; on the other hand, the daily balance was less emphasized because the feces could not be considered. In the typhus and pneumonia cases, the balance was also accurately determined in addition to the hourly amounts. In cases in which the determination of the hourly amounts appeared to be without value, it has been omitted from the Tables.

The cases cited here are to be regarded as average cases of repeated observations which we have collected in the clinic and a report [on all these cases] would needlessly expand this paper

Case I. B.O., 17 years. Typhus abdominalis.

Case history: patient comes from a healthy family. He suffered from measles as a child, but claims to have been always healthy since then. Ten days ago he became sick with headaches, loss of appetite, and diarrhea.

Present state: nothing abnormal discovered at the external and internal organs. Mild roseola, spleen moderately enlarged.

The patient has been put on a diet consisting of 1,200 cc milk, 800 cc broth with egg, 500-800 cc wine.

This diet contained

| | |
|--------|-------------------------|
| 10,340 | gram nitrogen per day |
| 6,246 | gram chlorine per day |
| 1,260 | gram phosphorus per day |
| 1,740 | gram calcium per day |
| 2,748 | gram potassium per day |
| 3,562 | gram sodium per day |

and has been maintained during the entire experimental series.

The feces were not considered because the examination days had been picked at random from the individual periods. The fact that the feces were not analysed introduces errors pertaining only to calcium. The amount of the other components is little affected by defecation.

The urine was collected in daytime and nighttime portions for three days. The first day was during the fever period.

| | | | | |
|-----------------------------|------|------|------|------|
| Temperature during 24 hours | 38.6 | 39.5 | 38.1 | 38.5 |
| pulsation | 106 | 108 | 104 | 100 |

The patient was bathed once a day; the temperature of the water was 30°.

The second day of urine examination was in the stage of decreasing temperature.

| | | | | |
|---------------------------------------|------|------|------|------|
| Temperature on the day of examination | 37.2 | 36.8 | 38.2 | 38.1 |
| pulsation | 76 | 80 | 92 | 88 |

The third day belongs to the fever-free period.

| | | | | |
|-------------|------|------|------|------|
| Temperature | 36.4 | 36.6 | 36.7 | 36.5 |
| pulsation | 76 | 68 | 68 | 76 |

This examination was supposed to indicate the typhus of urine during the fever period and of the urine from the afebrile periods. The numbers found were calculated for the hourly eliminations.

The balance was made without consideration of the feces. Table I. B.O., 17 years of age. Typhus abdominalis.

| | | | | |
|-------------|------|------|------|--------------------------|
| Temperature | 38.6 | 39.5 | 38.1 | 38.5 climax of the fever |
| Pulsation | 106 | 108 | 104 | 100 |

From 6 AM to 6 PM

Amount of urine 1,300 cc, specific weight 1015.

| | | | | | | |
|-----------------|--------|---|--------------|--------|----------|-------|
| N | 1.001 | % | per 12 hours | 10.013 | per hour | 1.084 |
| Cl | 0.212 | % | " " " | 2.756 | " " | 0.229 |
| P | 0.077 | % | " " " | 1.141 | " " | 0.095 |
| Ca | 0.0082 | % | " " " | 0.106 | " " | 0.009 |
| K | 0.159 | % | " " " | 2.067 | " " | 0.172 |
| Na | 0.142 | % | " " " | 1.937 | " " | 0.161 |
| urea | 0.840 | % | " " " | 10.920 | " " | 0.916 |
| uric acid | 0.014 | % | " " " | 0.182 | " " | 0.015 |
| allox. | | | | | | |
| bases | 0.018 | % | calcu- | 0.234 | " " | 0.019 |
| xanthine | | | lated | | | |
| bases | 0.004 | % | as N | 0.054 | " " | 0.064 |
| NH ₃ | 0.057 | % | " " " | 0.742 | " " | 0.062 |

From 6 PM to 6 AM

Amount of urine 590 cc, specific weight 1016

| | | | | | | |
|-----------------|--------|---|--------------|--------|----------|---------|
| N | 1.218 | % | per 12 hours | 7.186 | per hour | 0.599 g |
| Cl | 0.206 | % | " " " | 1.215 | " " | 1.101 g |
| P | 0.1177 | % | " " " | 0.694 | " " | 0.058 g |
| Ca | 0.0058 | % | " " " | 0.034 | " " | 0.003 g |
| K | 0.183 | % | " " " | 0.079 | " " | 0.090 g |
| Na | 0.116 | % | " " " | 0.684 | " " | 0.057 g |
| urea | 0.984 | % | " " " | 0.306 | " " | 0.484 g |
| uric acid | 0.012 | % | " " " | 0.0708 | " " | 0.006 g |
| allox | | | | | | |
| bases | 0.021 | % | calcu- | 0.177 | " " | 0.015 g |
| xanthine | | | lated | | | |
| bases | 0.009 | % | as N | 0.0531 | " " | 0.004 g |
| NH ₃ | 0.079 | % | " " " | 0.466 | " " | 0.040 g |

Result

| Food | Urine | Balance |
|----------|--------|--------------|
| N 10.340 | 20.199 | - 9.859 g N |
| Cl 6.246 | 3.971 | + 2.275 g Cl |
| P 1.266 | 1.835 | - 0.575 g P |
| Ca 1.740 | 0.140 | + 1.600 g Ca |
| K 2.748 | 3.146 | - 0.398 g K |
| Na 3.562 | 2.621 | + 0.941 g Na |

16.726 urea N
 0.253 uric acid N
 0.411 allomuric bases N
 0.158 xanthine bases N
 1.208 ammonia N

Note: When possible losses in the feces are included, the result becomes more pronounced but it remains essentially unchanged. N, also P, may be excreted in still larger amounts, calcium may be retained to a lesser extent. Chlorine, potassium, and sodium remain essentially unchanged because the amount of feces is very small.

Remission

| | | | | |
|-------------|------|------|------|------|
| Temperature | 37.2 | 36.8 | 38.2 | 38.1 |
| Pulsation | 76 | 80 | 92 | 69 |

From 6 AM to 6 PM

Amount of urine 510 cc, specific weight 1013

| | | | | | | |
|-----------------|--------|---|--------------|--------|----------|--------|
| N | 0.7945 | % | per 12 hours | 4.052 | per hour | 0.338 |
| Cl | 0.2548 | % | " " " | 1.299 | " " | 0.108 |
| P | 0.0594 | % | " " " | 0.3029 | " " | 0.025 |
| Ca | 0.0055 | % | " " " | 0.0281 | " " | 0.002 |
| K | 0.1170 | % | " " " | 0.5967 | " " | 0.049 |
| Na | 0.167 | % | " " " | 0.8517 | " " | 0.071 |
| urea | 0.672 | % | " " " | 3.427 | " " | 0.289 |
| uric acid | 0.0098 | % | " " " | 0.0499 | " " | 0.004 |
| allox. | | | | | | |
| bases | 0.0126 | % | " " " | 0.0643 | " " | 0.005 |
| xanthine | | | | | | |
| bases | 0.0023 | % | " " " | 0.0144 | " " | 0.001 |
| NH ₃ | 0.0434 | % | " " " | 0.2213 | " " | 0.0188 |

From 6 PM to 6 AM

Amount of urine 380 cc specific weight 1020

| | | | | | | |
|-----------------|--------|---|--------------|--------|----------|-------|
| N | 1.330 | % | per 12 hours | 5.504 | per hour | 0.421 |
| Cl | 0.309 | % | " " " | 1.295 | " " | 0.108 |
| P | 0.1566 | % | " " " | 0.710 | " " | 0.060 |
| Ca | 0.0075 | % | " " " | 0.0285 | " " | 0.002 |
| K | 0.1877 | % | " " " | 0.713 | " " | 0.060 |
| Na | 0.2126 | % | " " " | 0.806 | " " | 0.065 |
| urea | 1.176 | % | " " " | 4.474 | " " | 0.373 |
| uric acid | 0.017 | % | " " " | 0.0646 | " " | 0.005 |
| allox | | | | | | |
| bases | 0.0224 | % | " " " | 0.851 | " " | 0.007 |
| xanthine | | | | | | |
| bases | 0.0054 | % | " " " | 0.0205 | " " | 0.002 |
| NH ₃ | 0.0616 | % | " " " | 0.2341 | " " | 0.020 |

| | Food | Urine | Result |
|----|--------|-------|------------|
| N | 10.349 | 9.106 | + 1.234 or |
| Cl | 6.246 | 2.594 | + 3.652 |
| P | 1.260 | 1.013 | + 0.247 or |
| Ca | 1.740 | 0.056 | + 1.684 |
| K | 2.748 | 1.319 | + 1.429 |
| Na | 3.562 | 1.657 | + 1.905 |

| | | |
|-----------------|--------|-------------------|
| urea | 7.901 | } calculated as N |
| uric acid | 0.1145 | |
| alloxuric bases | 0.1494 | |
| xanthine bases | 0.0349 | |
| ammonia | 0.4554 | |

Note: The results may be substantially changed when the losses in the feces are included. Thus, a loss in N may occur after a loss in phosphorus; calcium may be retained less. The other quantities remain the same. The behavior of potassium must be pointed out; potassium is sparingly excreted -- in agreement with the observation made by Salkowsky.

Afebrile Period

| | | | | |
|-------------|------|------|------|------|
| Temperature | 36.4 | 36.6 | 36.0 | 36.5 |
| Pulsation | 76 | 68 | 68 | 76 |

From 6 AM to 6 PM

Amount of urine 1,200 cc, specific weight 1013.

| | | | | | |
|-----------------|----------|--------------|-------|----------|--------|
| N | 0.7945 % | per 12 hours | 9.534 | per hour | 0.794 |
| Cl | 0.3944 % | " " " | 4.733 | " " | 0.394 |
| P | 0.0454 % | " " " | 0.545 | " " | 0.045 |
| Ca | 0.0090 % | " " " | 0.108 | " " | 0.009 |
| K | 0.1990 % | " " " | 2.388 | " " | 0.1990 |
| Na | 0.2043 % | " " " | 2.448 | " " | 0.2040 |
| urea | 0.680 % | " " " | 8.160 | " " | 0.680 |
| uric acid | 0.0090 % | " " " | 0.108 | " " | 0.009 |
| allox. | | | | | |
| bases | 9.0136 % | " " " | 0.163 | " " | 0.0136 |
| xanthine | | | | | |
| bases | 0.0046 % | " " " | 0.053 | " " | 0.0046 |
| NH ₃ | 0.0420 % | " " " | 0.504 | " " | 0.042 |

From 6 PM to 6 AM

| | | | | | |
|----|----------|--------------|--------|----------|-------|
| N | 1.155 % | per 12 hours | 6.468 | per hour | 0.539 |
| Cl | 0.4368 % | " " " | 2.445 | " " | 0.204 |
| P | 0.0864 % | " " " | 0.484 | " " | 0.401 |
| Ca | 0.0664 % | " " " | 0.0358 | " " | 0.003 |

| | | | | | | |
|-----------------|--------|---|--------------|--------|----------|-------|
| K | 0.297 | % | per 12 hours | 1.663 | per hour | 0.139 |
| Na | 0.209 | % | " " " | 1.171 | " " | 0.099 |
| urea | 0.966 | % | " " " | 5.409 | " " | 0.451 |
| uric acid | 0.014 | % | " " " | 0.0784 | " " | 0.006 |
| allox. | | | | | | |
| bases | 0.0189 | % | " " " | 0.1058 | " " | 0.009 |
| xanthine | | | | | | |
| bases | 0.0049 | % | " " " | 0.0274 | " " | 0.003 |
| NH ₃ | 0.0616 | % | " " " | 0.3449 | " " | 0.029 |

| Food | Urine | Result |
|----------|--------|---------|
| N 10.340 | 16.002 | - 5.662 |
| Cl 6.246 | 7.178 | - 0.932 |
| P 1.260 | 1.029 | + 0.231 |
| Ca 1.740 | 0.144 | + 1.596 |
| K 2.748 | 4.051 | - 1.305 |
| Na 3.562 | 3.619 | - 0.057 |

| | | |
|-----------------|--------|-------------------|
| urea | 13.569 | } calculated as N |
| uric acid | 0.186 | |
| alloxuric bases | 0.269 | |
| xanthine bases | 0.083 | |
| ammonia | 0.849 | |

Note: The result cannot be substantially changed when the components in the feces are considered. Nitrogen would be eliminated to an increased extent, phosphorus would perhaps remain in equilibrium, calcium would be less retained. The other components were all excreted to an increased extent. Again, the behavior of K is striking because its excretion is considerably increased.

This case was supposed to provide us with information about the behavior of the salts during a fever spell. When the results of the first day (climax of the fever) are compared to those of the last day, a rather typical picture is obtained. In the former case, chloride and sodium are retained, phosphorus is lost; in the latter case, chlorine and sodium are lost, phosphorus is retained — exactly the reverse [of the former case]. The behavior of the nitrogen and the potassium salts must not lead us astray. This behavior is subject to other laws, as is known, the nature of which we have to discuss. The period of the remission exhibits a real transition between both periods when the correction for the noninclusion of the feces components is made.

As far as the nitrogen-containing components of urine are concerned, they also behaved quite typically: during the fever, there was an increased amount of uric acid, xanthine bases and alloxuric bases, in general, (as calculated sum of the xanthine bases and uric acid) an increased excretion of ammonia.

fever $\frac{\text{urea}}{\text{N}}$ 0.83; $\frac{\text{uric acid}}{\text{N}}$ 0.012; $\frac{\text{alloxuric bases}}{\text{N}}$ (0.020, $\frac{\text{NH}_3}{\text{N}}$) 0.000

Afebrile period " 0.85 " 0.011 " 0.017 " 0.053

Also Zülzer's ratio P/N was typical

fever P/N 0.0917 fever-free stage P/N 0.064

Finally, when the ratio of N in the other components in the food and in the urine is formed, the following results for the fever stage:

| | | | | | |
|---------|--------|----------|-------|-------|--------------------|
| N: Cl: | P: | Ca: | K: | Na: | |
| 1:0.62 | 0.12 | 0.17 | 0.27 | 0.35 | in the food |
| 1:0.198 | 0.0917 | (0.007*) | 0.157 | 0.131 | in the elimination |

For the remission period

| | | | | | |
|----|-------|-------|-------|-------|-------|
| N: | Cl: | P: | Ca: | K: | Na: |
| 1: | 0.286 | 0.111 | 0.006 | 0.146 | 0.182 |

For the afebrile period

| | | | | | |
|---------|-------|---------|-------|-------|--------------------|
| N: Cl: | P: | Ca: | K: | Na: | |
| 1:0.62 | 0.12 | 0.17 | 0.27 | 0.35 | in the food |
| 1:0.448 | 0.064 | (0.009) | 0.253 | 0.226 | in the elimination |

| | | | | | |
|---------------------|----|-------|-----------|-----------------|-----------------|
| | N: | urea | uric acid | alloxuric bases | NH ₃ |
| climax of the fever | | 0.836 | 0.0126 | 0.0205 | 0.0604 |
| remission | | 0.868 | 0.0125 | 0.0164 | 0.0500 |
| afebrile period | | 0.878 | 0.0084 | 0.0168 | 0.0530 |

It is seen that: 1. none of the urine components are excreted to such an extent as the nitrogen components, 2. the fever-free period is characterized by an improvement in the ratio of the chlorides to the potassium salts.

This for the typical behavior during fever. In case II which is also a typhus case, we can study the changes with respect to the increase in body temperature.

Case II 2A., 32 years. Typhus abdominalis.

Case history does not disclose anything which would be of importance. Patient comes from a healthy family; he has been completely healthy until now. The present disease started 12 days ago. Patient lost sleep and appetite, did

* Only in urine

not feel well and had himself admitted to the hospital to obtain better food.

Present status: No essential changes of the internal and external organs. Nothing can be discovered except for a distinct swelling of the spleen.

The patient received the same diet as Case I: 1,200 cc milk, 800 [cc] broth with egg, and 1/2 liter of wine. This diet was kept unchanged until the end of the experiment. As in all other cases, the amount was measured. All foodstuffs were analyzed by us.

The patient was examined by us for the components under consideration and the amount of the components per day was calculated by calculating the total amount from the percentages, and this total amount was divided by the number of days.

The urine was measured daily and examined daily. The daily loss of N, Cl, P, Ca, K, Na and NH_3 and other nitrogen compounds was determined from the urine. All other figures were calculated as Cl, Na, K, P, Ca (not as P_2O_5 , NaCl, et cetera). The nitrogen compounds were all recalculated in terms of nitrogen, obtaining, thus, the amount of nitrogen excreted as NH_3 , uric acid, allomuric bases (uric acid and xanthine), and xanthine.

At the beginning of the experiment, the temperature was ascending, reached its maximum, and then dropped to normal. The effect of the increase and of the drop was thereby observed.

| | | | | | |
|---------|------|------|------|------|-------------|
| 13 July | 38.9 | 38.7 | 39.5 | 39.2 | Temperature |
| | 88 | 90 | 100 | 96 | Pulsation |
| 14 July | 39.0 | 39.5 | 39.0 | 38.6 | Temperature |
| | 92 | 100 | 96 | 92 | Pulsation |
| 15 July | 37.8 | 38.4 | 38.5 | 39.0 | Temperature |
| | 100 | 96 | 100 | 92 | Pulsation |
| 16 July | 38.5 | 39.5 | 39.9 | 39.6 | Temperature |
| | 92 | 92 | 96 | 96 | Pulsation |
| 17 July | 38.6 | 39.6 | 38.8 | 37.5 | Temperature |
| | 89 | 92 | 96 | 84 | Pulsation |
| 18 July | 37.5 | 38.1 | 39.5 | 39.0 | Temperature |
| | 84 | 96 | 100 | 92 | Pulsation |
| 19 July | 37.6 | 39.4 | 40.1 | 39.0 | Temperature |
| | 92 | 96 | 100 | 101 | Pulsation |
| 20 July | 37.6 | 37.2 | 37.2 | 38.2 | Temperature |
| | 100 | 100 | 96 | 100 | Pulsation |
| 21 July | 36.5 | 37.2 | 39.3 | 38.9 | Temperature |
| | 96 | 96 | 96 | 112 | Pulsation |
| 22 July | 38.9 | 37.5 | 37.8 | 38.5 | Temperature |
| | 104 | 101 | 101 | 86 | Pulsation |
| 23 July | 37.0 | 37.1 | 38.3 | 38.5 | Temperature |
| | 92 | 88 | 100 | 96 | Pulsation |
| 24 July | 36.2 | 37.3 | 38.2 | 38.3 | Temperature |
| | 84 | 98 | 100 | 92 | Pulsation |

Table II. Typhus abdominalis

| 14 July temperature 39.1, amount of urine 800 cc, specific weight 1026 | | | | | | | | | |
|--|-----------|---------|---------|--------|--------------|--------|-------------|--------|--------|
| | 2.289 % | 18.212 | per day | 0.5267 | in the feces | 10.340 | in the food | | |
| N | 0.2427 % | 1.9416 | " | 0.4669 | " | 6.246 | " | -8.499 | +3.837 |
| Cl | 0.1450 % | 1.1600 | " | 0.2912 | " | 1.260 | " | -0.191 | +1.310 |
| P | 0.0175 % | 0.1400 | " | 0.1901 | " | 1.740 | " | +1.581 | +2.670 |
| Ca | 0.0985 % | 0.7380 | " | 0.3795 | " | 2.748 | " | | |
| K | 0.0905 % | 0.7240 | " | 0.1683 | " | 3.562 | " | | |
| Mn | 1.806 % | 14.4480 | " | | | | | | |
| urea | 0.0224 % | 0.1792 | " | | | | | | |
| uric acid | | | " | | | | | | |
| alloxuric bases | 0.0289 % | 0.2312 | " | | | | | | |
| xanthine bases | 0.0065 % | 0.0520 | " | | | | | | |
| NH ₃ | 0.09035 % | 0.7224 | " | | | | | | |
| 15 July temperature 38.4, amount of urine 820 cc, specific weight 1027 | | | | | | | | | |
| | 1.757 % | 14.507 | per day | 0.5267 | in the feces | 10.340 | in the food | | |
| N | 0.4371 % | 3.496 | " | 0.4669 | " | 6.246 | " | -4.694 | +2.283 |
| Cl | 0.1250 % | 1.025 | " | 0.2912 | " | 1.260 | " | -0.056 | +1.369 |
| P | 0.0222 % | 0.1810 | " | 0.1901 | " | 1.740 | " | +1.711 | +2.163 |
| Ca | 0.0802 % | 0.6576 | " | 0.3795 | " | 2.748 | " | | |
| K | 0.1495 % | 1.2259 | " | 0.1683 | " | 3.562 | " | | |
| Na | 1.526 % | 12.5132 | " | | | | | | |
| urea | 0.0217 % | 0.1779 | " | | | | | | |
| uric acid | | | " | | | | | | |
| alloxuric bases | 0.0289 % | 0.2379 | " | | | | | | |
| xanthine bases | 0.0072 % | 0.0607 | " | | | | | | |
| NH ₃ | 0.0861 % | 0.7860 | " | | | | | | |

16 July temperature 39.4; amount of urine 1,220 cc, spec. weight 1026

| | | | | | | | | |
|-----------------|----------|---------|---------|--------|--------------|--------|-------------|---------|
| H | 1.6625 % | 20.2775 | per day | 0.5267 | in the feces | 10.340 | in the food | -10.465 |
| Cl | 0.4368 % | 5.3289 | " | 0.4669 | " | 6.246 | " | + 0.451 |
| P | 0.0860 % | 1.0492 | " | 0.2912 | " | 1.260 | " | + 0.080 |
| Ca | 0.0076 % | 0.0927 | " | 0.1901 | " | 1.740 | " | + 1.457 |
| K | 0.0832 % | 0.0150 | " | 0.3795 | " | 2.748 | " | + 1.353 |
| Na | 0.1493 % | 1.8215 | " | 0.1683 | " | 2.562 | " | + 1.572 |
| urea | 1.518 % | 19.519 | " | | | | | |
| uric acid | 0.0210 % | 0.2562 | " | | | | | |
| allomuric | | | " | | | | | |
| bases | 0.0298 % | 0.3635 | " | | | | | |
| xanthine | | | " | | | | | |
| bases | 0.0088 % | 0.1073 | " | | | | | |
| NH ₃ | 0.0875 % | 1.0675 | " | | | | | |

17 July temperature 38.6 amount of urine 700 cc, spec. weight 1030

| | | | | | | | | |
|-----------------|-----------|---------|---------|--------|--------------|--------|-------------|--------|
| H | 1.967 % | 13.769 | per day | 0.5267 | in the feces | 10.340 | in the food | -3.956 |
| Cl | 0.2123 % | 1.486 | " | 0.4669 | " | 6.246 | " | +4.292 |
| P | 0.1520 % | 1.064 | " | 0.2912 | " | 1.260 | " | -0.095 |
| Ca | 0.0191 % | 0.1337 | " | 0.1901 | " | 1.740 | " | +1.419 |
| K | 0.1134 % | 0.7938 | " | 0.3795 | " | 2.748 | " | +1.575 |
| Na | 0.0664 % | 0.4648 | " | 0.1683 | " | 3.562 | " | +2.929 |
| urea | 1.736 % | 12.1520 | " | | | | | |
| uric acid | 0.02345 % | 0.1641 | " | | | | | |
| allomuric | | | " | | | | | |
| bases | 0.03174 % | 0.2221 | " | | | | | |
| xanthine | | | " | | | | | |
| bases | 0.00829 % | 0.0580 | " | | | | | |
| NH ₃ | 0.0972 % | 0.6804 | " | | | | | |

! K .

18 July temperature 38.5, amount of urine 800 cc, spec. weight 1026

| | | | | | | | | |
|-----------------|----------|---------|---------|--------|--------------|--------|-------------|--------|
| N | 2.037 % | 16.296 | per day | 0.5267 | in the feces | 10.340 | in the food | -6.483 |
| Cl | 0.3034 % | 2.427 | " | 0.4669 | " | 6.246 | " | +3.353 |
| P | 0.1890 % | 1.513 | " | 0.2912 | " | 1.260 | " | -0.544 |
| Ca | 0.0288 % | 0.2300 | " | 0.1901 | " | 1.740 | " | +1.320 |
| K | 0.0893 % | 0.7144 | " | 0.3795 | " | 2.748 | " | +1.654 |
| Na | 0.0785 % | 0.6280 | " | 0.1683 | " | 3.562 | " | +2.766 |
| urea | 1.708 % | 13.6640 | " | | | | | |
| uric acid | 0.0297 % | 6.2380 | " | | | | | |
| alloxuric | | | " | | | | | |
| bases | 0.0389 % | 0.3115 | " | | | | | |
| xanthine | | | " | | | | | |
| bases | 0.0092 % | 0.0735 | " | | | | | |
| NH ₃ | 0.1127 % | 0.9016 | " | | | | | |

19 July temperature 39.0, amount of urine 500 cc, spec. weight 1030

| | | | | | | | | |
|-----------------|-----------|--------|---------|--------|--------------|--------|-------------|--------|
| N | 1.9915 % | 9.9575 | per day | 0.5267 | in the feces | 10.340 | in the food | -0.144 |
| Cl | 0.3034 % | 1.517 | " | 0.4669 | " | 6.246 | " | +4.263 |
| P | 0.1425 % | 0.713 | " | 0.2912 | " | 1.260 | " | +0.257 |
| Ca | 0.01793 % | 0.0897 | " | 0.1901 | " | 1.740 | " | +1.461 |
| K | 0.1125 % | 0.5625 | " | 0.3795 | " | 2.748 | " | +1.806 |
| Na | 0.0459 % | 0.2295 | " | 0.1683 | " | 3.562 | " | +3.165 |
| urea | 1.708 % | 8.5400 | " | | | | | |
| uric acid | 0.02625 % | 0.1313 | " | | | | | |
| alloxuric | | | " | | | | | |
| bases | 0.03197 % | 0.1598 | " | | | | | |
| xanthine | | | " | | | | | |
| bases | 0.00572 % | 0.0285 | " | | | | | |
| NH ₃ | 0.1519 % | 0.7595 | " | | | | | |

20 July temperature 37.5, amount of urine 450 cc, spec. weight 1028

| | | | | | | | | | |
|-----------------|--------|---|--------|---------|--------|--------------|--------|-------------|--------|
| N | 2.597 | % | 11.687 | per day | 0.5267 | in the feces | 10.340 | in the food | -1.884 |
| Cl | 0.2548 | % | 1.147 | " | 0.4669 | " | 6.246 | " | +4.632 |
| P | 0.1640 | % | 0.738 | " | 0.2912 | " | 1.260 | " | +0.231 |
| Ca | 0.0262 | % | 0.1180 | " | 0.1901 | " | 1.740 | " | +1.432 |
| K | 0.0435 | % | 0.1953 | " | 0.3795 | " | 2.748 | " | +2.173 |
| Na | 0.0458 | % | 0.2061 | " | 0.1683 | " | 3.562 | " | +3.188 |
| urea | 1.736 | % | 7.812 | " | | | | | |
| uric acid | 0.0290 | % | 0.1305 | " | | | | | |
| alloxuric | | | | | | | | | |
| bases | 0.0364 | % | 0.1639 | " | | | | | |
| xanthine | | | | | | | | | |
| bases | 0.0074 | % | 0.0334 | " | | | | | |
| NH ₃ | 0.1820 | % | 0.8190 | " | | | | | |

21 July temperature 38.0, amount of urine 600 cc, spec. weight 1026

| | | | | | | | | | |
|-----------------|--------|---|--------|---------|--------|--------------|--------|-------------|--------|
| N | 2.072 | % | 12.432 | per day | 0.5267 | in the feces | 10.340 | in the food | -2.618 |
| Cl | 0.3943 | % | 2.365 | " | 0.4669 | " | 6.246 | " | +3.415 |
| F | 0.1250 | % | 0.750 | " | 0.2912 | " | 1.260 | " | +0.223 |
| Ca | 0.0155 | % | 0.093 | " | 0.1901 | " | 1.740 | " | +1.463 |
| K | 0.0825 | % | 0.4950 | " | 0.3795 | " | 2.748 | " | +1.873 |
| Na | 0.0710 | % | 0.4260 | " | 0.1683 | " | 3.562 | " | +2.868 |
| urea | 1.652 | % | 9.912 | " | | | | | |
| uric acid | 0.0329 | % | 0.1974 | " | | | | | |
| alloxuric | | | | | | | | | |
| bases | 0.0409 | % | 0.2457 | " | | | | | |
| xanthine | | | | | | | | | |
| bases | 0.0080 | % | 0.0483 | " | | | | | |
| NH ₃ | 0.1400 | % | 0.6400 | " | | | | | |

22 July temperature 38.1 amount of urine 600 cc, spec weight 1027

| | | | | | | | |
|-----------------|----------|--------|---------|--------|--------------|--------------------|--------|
| N | 1.7500 % | 10.500 | per day | 0.5267 | in the feces | 10.340 in the food | -0.686 |
| Cl | 0.3701 % | 2.220 | " | 0.4669 | " | " | +3.560 |
| P | 0.1150 % | 0.690 | " | 0.2912 | " | " | +0.279 |
| Ca | 0.0164 % | 0.0984 | " | 0.1901 | " | " | +1.458 |
| K | 0.0810 % | 0.486 | " | 0.3795 | " | " | +1.883 |
| Na | 0.0923 % | 0.5538 | " | 0.1583 | " | " | +2.840 |
| urea | 1.680 % | 9.080 | " | | | | |
| uric acid | 0.0294 % | 0.1764 | " | | | | |
| alloxuric | | | | | | | |
| bases | 0.0373 % | 0.2235 | " | | | | |
| xanthine | | | | | | | |
| bases | 0.0078 % | 0.0471 | " | | | | |
| NH ₃ | 0.1232 % | 0.7392 | " | | | | |

When considering the second table, it is noted, above all, that the body appears to react differently toward the increase in temperature in the initial stage than in the remission stage. The increase in temperature during the first days is connected with an increased elimination of nitrogen. However, once the temperature has dropped to normal, an increase in temperature is accompanied by a decrease in N-elimination. (This rule is by no means always true and we will specially emphasize those cases in which it is true. Most observations show a parallel behavior of fever height and nitrogen loss.)

The chlorine elimination should be opposite to the nitrogen [elimination], that is, it should increase with the drop in body temperature. This is mostly so in our case; but even here an increase in temperature after the fever spell is connected with an increase in chlorine separation -- an observation which has been made by many authors (Rosenstein, Brattler), but which has not been sufficiently emphasized.

The phosphorus elimination exhibits a certain sluggishness, it lasts longer than the temperature drop and decreases only when the fever is over for a long time. When the temperature drops, the elimination of phosphorus may increase; when the temperature increases the phosphorus elimination may drop. We find such behavior in our case in addition to the above-mentioned abnormalities of the nitrogen and chlorine elimination.

The elimination of calcium salts has been little observed until now; there are no data and we must limit ourselves to the mere mentioning of this observation. In this case, the calcium elimination was opposite to the temperature. Any drop [in temperature] brought about an increase in the calcium elimination; any increase [in temperature] brought about a drop in calcium elimination. It cannot be decided whether this is specific for typhus.

According to Salkowsky, the potassium salts are eliminated to an increased extent during the fever; after the fever, they decrease considerably and disappear gradually. We can completely agree to this rule. In fact, it appears that this situation is not affected by an accidental drop or increase in temperature. To be sure, a drop in potassium salt elimination has been observed during a rapid ascent of the temperature, but this does not narrow down the validity of the rule. The parallel behavior, which some believed to have observed between P and K, does not exist in this case; a divergent behavior is frequently noted.

The sodium salts behave in the same way as chlorine; thus in our case they undergo the same fluctuations and abnormalities, as have been discussed in the case of the chlorine elimination.

The elimination of ammonia need not be specially discussed. According to Hallervorden (see reference cited), its elimination is supposedly increased during the fever. It could therefore be set equal to phosphorus and nitrogen. In our cases, the elimination of ammonia is actually parallel to

that of phosphorus and exhibits the fluctuations discussed for the case of phosphorus. Therefore, a similarity between P and ammonia is more justified than one between potassium salt* and phosphorus*.

The other nitrogen-containing substances exhibit a complete dependence on the total elimination of nitrogen. I refer to the statements made in connection with the nitrogen elimination and to the Table given below.

The above-discussed case does not exhibit a continuous decrease in temperature; on the contrary, two recurrences are observed; these were welcome because we did not want to study the behavior during fever, but the behavior during changes in the course of the fever.

Table III

| Temp. | $\frac{\text{Cl}}{\text{N}}$ | $\frac{\text{P}}{\text{N}}$ | $\frac{\text{Ca}}{\text{N}}$ | $\frac{\text{K}}{\text{N}}$ | $\frac{\text{Na}}{\text{N}}$ | $\frac{\text{urica}}{\text{N}}$ | $\frac{\text{uric acid}}{\text{N}}$ | $\frac{\text{allex. bases}}{\text{N}}$ | $\frac{\text{NH}_3}{\text{N}}$ |
|-------|------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|---------------------------------|-------------------------------------|--|--------------------------------|
| 39.1 | 0.107 | 0.065 | 0.0076 | 0.043 | 0.0402 | 0.800 | 0.0099 | 0.0128 | 0.0401 |
| 38.5 | 0.241 | 0.070 | 0.0125 | 0.045 | 0.0845 | 0.862 | 0.0122 | 0.0164 | 0.0542 |
| 39.4 | 0.266 | 0.052 | 0.0046 | 0.051 | 0.0911 | 0.975 | 0.0128 | 0.0182 | 0.0533 |
| 38.6 | 0.108 | 0.077 | 0.0090 | 0.057 | 0.0337 | 0.882 | 0.0119 | 0.0161 | 0.0473 |
| 38.5 | 0.148 | 0.093 | 0.0141 | 0.044 | 0.0385 | 0.838 | 0.0146 | 0.0191 | 0.0553 |
| 39.0 | 0.152 | 0.071 | 0.0089 | 0.056 | 0.0229 | 0.855 | 0.0131 | 0.0160 | 0.0760 |
| 37.5 | 0.098 | 0.063 | 0.0101 | 0.0167 | 0.0176 | 0.668 | 0.0111 | 0.0140 | 0.0700 |
| 38.0 | 0.190 | 0.060 | 0.0075 | 0.0400 | 0.0343 | 0.800 | 0.0159 | 0.0199 | 0.0677 |
| 38.1 | 0.211 | 0.065 | 0.0093 | 0.046 | 0.0526 | 0.864 | 0.0167 | 0.0217 | 0.0700 |

Table III has been constructed in such a way that the ratio of the daily elimination of urine components and of the nitrogen elimination was formed. Represented in this manner, the results show even more clearly the fluctuations occurring during an increase and during a drop in body temperature. The chlorides are always increased during an increase in temperature, and they are decreased during a drop in temperature. The phosphates behave exactly in a reverse way: they are increased during a temperature drop, and they are decreased during a raise in temperature. Calcium exhibits most clearly its antagonistic behavior with respect to the course of the temperature. Potassium behaves irregularly, even when these figures are considered, and it does not agree with phosphorus in its behavior. The ammonia is to be compared more likely with chlorine, however not as strictly as sodium. The nitrogen-containing compounds behave more or less in accordance with the temperature.

* This behavior of NH_3 indicates an acid elimination which we have often emphasized and which, in most cases, takes place in the form of phosphoric acid.

Case III. M. G. 20 years of age. Feverish pneumonia.

Case history: father of the patient died supposedly of tuberculosis, the brothers and sisters are reportedly healthy. The patient himself was well until now. Three days ago he became sick with twinges in the sides and the appearance of fever chills.

Present state: nothing abnormal is detectable at the organs, except for an extended dampening in the left lung. Cultivation tests confirm the diagnosis of pneumonia. The expectoration is of a rusty color and sparse. The appetite is highly reduced.

The nutrition consisted of milk and broth with egg. The amount was accurately measured.

The investigation began directly after admission to the hospital. The fever was high: 38.8 to 39.7. The urine was collected during the fever period and quantitatively analyzed for N, Cl, P, Ca. The nurse had been instructed to collect separately all urine on the day of the crisis prior to onset of sweating; therefore, the second portion of urine collected on the day of the crisis belongs to the afebrile period. On the subsequent days, the entire urine was collected and examined. After onset of the crisis, the fever rose again to a maximum, which was desirable for our studies. This day can be immediately recognized on the Table. After this rise in the fever, the temperature dropped and remained normal until the end of the experiment. The urine was quantitatively analyzed for all components during the crisis and on the four subsequent days; it was then analyzed for N, Cl, P, and Ca on two additional days.

Nitrogen, chlorine, phosphorus, calcium, potassium, and sodium were determined in the feces, their total amounts were calculated and then distributed over the individual days

The temperature ran as follows:

| | | |
|----------|----------------------|---------------------|
| 28 July | 38.8 to 39.7 | Pulsation 100 to 96 |
| 29 July | 38.5 to 39.3 to 39.0 | " 112 to 100 to 104 |
| 30 July | 38.1 to 39.5 to 39.7 | " 96 to 100 to 99 |
| 31 July | 37.8 to 39.7 to 38.8 | " 96 to 108 to 96 |
| | 37.1 to 36.7 | " 92 to 96 |
| 1 August | 37.5 to 39.3 to 38.0 | " 96 to 104 to 108 |
| 2 August | 37.7 to 36.2 | " 86 to 84 |
| 3 August | 36 | " 72 |
| 4 August | 36 | " 70 |
| 5 August | 36 | " 70 |

Table IV

| Date | Temp. and Pulsation | Percent | Amt of Urine | Spec. Wt. | Per Day Urine in gram | Feces | Diet | Balance |
|------------------|--|---|-----------------|--------------|---|-------------------------|----------------------------------|--|
| 28.7 | 38.8 39.7 100 96 | N 2.275 Cl 0.0607 P 0.0500 | | | | | | |
| 29.7 | 38.5 112 39.3 100 39.0 104 | N 2.121 Cl 0.0556 P 0.0500 Ca 0.0109 | 1000 cc | 1.025 | 21.210 0.556 0.500 0.109 | 0.1514 g N per day | 2.028 0.533 0.403 0.544 | -19.333 - 0.025 - 0.181 + 0.223 |
| 30.7 | 38.1 96 39.5 100 39.7 104 | N 2.1665 Cl 0.0182 P 0.0810 Ca 0.0016 | 1000 cc | 1.026 | 21.665 0.082 0.810 0.016 | | 4.056 1.066 0.806 1.088 | -17.760 + 0.828 - 0.088 + 0.860 |
| 31.7 | 37.8 96 39.7 108 38.8 96 6 AM to 12 PM | N 2.170 Cl 0.0123 P 0.0560 Ca 0.0018 K 0.1506 Na 0.0652 urea 1.960 uric acid 0.0249 alloxuric bases 0.0371 xanthine bases 0.0122 NH ₃ 0.1057 | 460 cc | 1.025 | 9.982 0.0566 0.2576 0.0083 0.6927 0.3001 9.016 0.11454 0.17066 0.05612 0.4862 | 0.0018 g Cl 0.08374 g P | 4.056M | -18.865 |
| After the crisis | | | | | | | | |

| Date | Temp. and Pulsation | Percent | Amt of Urine | Spec. Wt. | Per Day Urine in gram | Feces | Diet | Balance |
|------------------------|-----------------------------|---------------------------|-----------------|--------------|-----------------------------|-------------------|----------|---------|
| After the crisis | 37.1 92 | N 2.247 | 570 cc | 1.026 | 12.8079 | 0.21238 g Calcium | 1.066 Cl | + 0.949 |
| | 36.7 96 | Cl 0.0124 | | | 0.0689 | | 0.806 P | - 0.248 |
| | 12 mid- night to 6 AM | P 0.1250 | | | 0.7125 | | 0.088 Ca | + 0.858 |
| | | Ca 0.0017 | | | 0.0097 | | 0.920 K | - 0.872 |
| | | K 0.1930 | | | 1.1004 | | 0.657 Na | + 0.256 |
| | | Na 0.0176 | | | 0.1014 | | | |
| | | urea 2.030 | | | 11.571 | | | |
| | | uric acid 0.0182 | | | 0.1037 | | | |
| | | alloxuric bases 0.0413 | | | 0.2314 | | | |
| | | xanthine bases 0.0231 | | | 0.1277 | | | |
| NH ₃ 0.1260 | 0.7182 | | | | | | | |
| 1. Aug. | 37.5 96 | N 2.3520 | 710 cc | 1.025 | 16.7992 | | 4.056 | -12.894 |
| | 39.3 104 | Cl 0.0061 | | | 0.0433 | | 1.066 | + 1.022 |
| | 38.0 108 | P 0.0500 | | | 0.355 | | 0.806 | + 0.367 |
| | | Ca 0.0012 | | | 0.0085 | | 1.088 | + 0.791 |
| | | K 0.2820 | | | 2.0020 | | 0.920 | - 1.082 |
| | | N 0.0138 | | | 0.0979 | | 0.657 | + 0.560 |
| | | uric acid 0.0217 | | | 0.1541 | | | |
| | | alloxuric bases 0.0434 | | | 0.3078 | | | |
| | | xanthine bases 0.0217 | | | 0.1541 | | | |
| | | NH ₃ 0.0721 | | | 0.5419 | | | |
| 2. Aug | 37.7 88 | N 2.352 | 500 cc | 1.028 | 12.760 | 0.15148 g N | 4.056 | - 8.955 |
| | 36.2 84 | Cl 0.0010 | | | 0.050 | | 1.066 | + 1.059 |
| | | P 0.0630 | | | 0.815 | | 0.806 | - 0.093 |
| | | Ca 0.0015 | | | 0.0075 | | 1.088 | + 0.769 |
| | | | | | | | | |

| Date | Temp. and Precipitation | Percent | Amt of Urine | Spec. Wt. | Per Day Urine in gram | Feces | Diet | Balance |
|-------|----------------------------|------------------------|-----------------|--------------|-----------------------------|--------------|-------|---------|
| 3 Aug | 36.1 72 | K 0.2518 | 500 cc | 1.028 | 1.259 | 0.15148 g N | 0.920 | - 0.239 |
| | | Na 0.0376 | | | 0.188 | | 0.657 | + 0.469 |
| | | uric acid 0.0157 | | | 0.0785 | | | |
| | | alloxuric | | | 0.231 | | | |
| | | bases 0.0462 | | | 0.1525 | | | |
| | | xanthine | | | 0.560 | | | |
| | | bases 0.0305 | | | 25.620 | | 4.056 | -21.715 |
| | | urea 0.112 | | | 0.1230 | | 1.066 | + 0.941 |
| | | N 2.562 | | | 0.7850 | | 0.806 | - 1.063 |
| | | Cl 0.0123 | | | 0.0160 | | 1.088 | + 0.861 |
| 4 Aug | 36.2 70 | Ca 0.0016 | 1000 cc | 1.025 | 2.1060 | 0.00182 g Cl | 0.920 | - 1.186 |
| | | K 0.2106 | | | 0.1880 | | 0.657 | + 0.469 |
| | | Na 0.0188 | | | 23.840 | | | |
| | | urea 2.384 | | | 0.280 | | | |
| | | uric acid 0.0280 | | | 0.510 | | | |
| | | alloxuric | | | 0.238 | | | |
| | | bases 0.0510 | | | 1.071 | | | |
| | | xanthine | | | 15.654 | | 2.028 | -13.777 |
| | | bases 0.0238 | | | 0.0083 | | 0.533 | + 0.523 |
| | | NE ₃ 0.1071 | | | 1.3201 | | 0.403 | - 1.001 |
| 4 Aug | 36.2 70 | N 1.8865 | 830 cc | 1.028 | 0.0714 | 0.08374 g P | 0.544 | + 0.261 |
| | | Cl 0.001 | | | 1.867 | | 0.460 | - 1.407 |
| | | P 0.1470 | | | 0.387 | | 0.325 | + 0.058 |
| | | Ca 0.0086 | | | 13.248 | | | |
| | | K 0.2256 | | | 0.1577 | | | |
| 4 Aug | 36.2 70 | Na 0.0468 | | | | | | |
| | | urea 1.596 | | | | | | |
| | | uric acid 0.01925 | | | | | | |

| Date | Temp. and Pulsation | Percent | Amt of Urine | Spec. Wt. | Per Day Urine in gram | Feces | Diet | Balance |
|-------|------------------------|---|-----------------|--------------|------------------------------------|--------------|----------------------------------|--|
| 4 Aug | 36.2 70 | allcoaric bases 0.04450 xanthine bases 0.02530 NH ₃ 0.0750 | 830 cc | 1.028 | 0.3652 0.2075 0.581 | 0.21238 g Ca | | |
| 5 Aug | 36.1 70 | N 1.995 Cl 0.0364 F 0.1885 Ca 0.0220 | 830 cc | 1.028 | 16.517 0.155 0.560 0.1830 | | 2.028 0.533 0.403 0.544 | -14.644 + 0.376 - 1.241 + 0.314 |
| 6 Aug | 36.5 70 | N 1.855 Cl 0.6068 F 0.121 Ca 0.00436 | 840 cc | 1.025 | 15.582 5.098 1.016 0.361 | | | |
| 7 Aug | 36.2 70 | N — Cl 0.7595 P 0.0965 Ca — | 870 cc | 1.025 | — 6.595 0.839 — | | | |

Table V
Table V represents the hourly elimination during eight days.

| Date | Temp. | N | Cl | P | Ca | K | Na | Urea | Uric Acid | Allox Bases | NH ₃ |
|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------------|----------------|-----------------|
| 29 Jul | 38.9 | 0.883 | 0.0230 | 0.021 | 0.0040 | - | - | - | - | - | - |
| 30 Jul | 39.1 | 0.903 | 0.0080 | 0.034 | 0.0007 | - | - | - | - | - | - |
| 31 Jul | 38.8 | 0.554 | 0.0032 | 0.0143 | 0.0005 | 0.0385 | 0.0168 | 0.5009 | 0.0063 | 0.0094 | 0.0270 |
| 31 Jul | 36.8 | 2.1363 | 0.0115 | 0.1887 | 0.0016 | 0.1433 | 0.0169 | 1.9285 | 0.0173 | 0.0386 | 0.1184 |
| 1 Aug | 38.3 | 0.6099 | 0.0018 | 0.0148 | 0.0004 | 0.0867 | 0.0041 | - | 0.0064 | 0.0128 | 0.0243 |
| 2 Aug | 36.9 | 0.500 | 0.0002 | 0.0340 | 0.0003 | 0.0525 | 0.0078 | - | 0.0032 | 0.0096 | 0.0266 |
| 3 Aug | 36.1 | 1.0675 | 0.0051 | 0.0741 | 0.0007 | 0.0875 | 0.0078 | 0.9917 | 0.0127 | 0.0216 | 0.0441 |
| 4 Aug | 36.1 | 0.652 | 0.0003 | 0.0550 | 0.0029 | 0.0775 | 0.0161 | 0.552 | 0.0066 | 0.0153 | 0.0864 |
| 5 Aug | 36.1 | 0.690 | 0.0068 | 0.0650 | 0.0076 | - | - | - | - | - | - |
| 6 Aug | 36.1 | 0.649 | 0.2109 | 0.0431 | 0.0150 | - | - | - | - | - | - |

Table VI
Table VI shows the ratio of the excreted amount with respect to the amount of nitrogen.

| Date | Temp | Cl | P | Ca | K | Na | Urea | Uric Acid | Allox Bases | NH ₃ |
|--------|------|--------|-------|---------|-------|--------|-------|--------------|----------------|-----------------|
| 29 Jul | 38.9 | 0.0260 | 0.024 | 0.0040 | - | - | - | - | - | - |
| 30 Jul | 39.1 | 0.0090 | 0.033 | 0.0008 | - | - | - | - | - | - |
| 31 Jul | 38.8 | 0.0060 | 0.026 | 0.0009 | 0.069 | 0.0303 | 0.903 | 0.0110 | 0.0168 | 0.049 |
| 31 Jul | 36.8 | 0.0050 | 0.084 | 0.0007 | 0.067 | 0.0079 | 0.865 | 0.0078 | 0.0173 | 0.054 |
| 1 Aug | 38.3 | 0.0030 | 0.021 | 0.00055 | 0.124 | 0.0058 | - | 0.0091 | 0.0183 | 0.0304 |
| 2 Aug | 36.9 | 0.0003 | 0.064 | 0.00056 | 0.098 | 0.004 | - | 0.0060 | 0.0180 | 0.042 |
| 3 Aug | 36.1 | 0.0049 | 0.069 | 0.0006 | 0.082 | 0.0073 | 0.929 | 0.0118 | 0.0201 | 0.041 |
| 4 Aug | 36.1 | 0.0004 | 0.084 | 0.0044 | 0.118 | 0.024 | 0.800 | 0.0101 | 0.023 | 0.132 |
| 5 Aug | 36.1 | 0.0098 | 0.094 | 0.0111 | - | - | - | - | - | - |
| 6 Aug | 36.1 | 0.022 | 0.063 | 0.0240 | - | - | - | - | - | - |

It is seen from Table IV that the loss in nitrogen may be larger after the crisis than during the fever. When the amount eliminated in the urine prior to and after the crisis is considered, the percentage content and also the absolute amounts of those components, whose elimination is characteristic for the fever, are found to be increased. This is observed even more distinctly when the hourly amounts are compared. It is found (Table V) that nitrogen and potassium are eliminated four times as much, chlorine and calcium three times as much, ammonia five times as much, and phosphorus eight times as much as prior to the crisis. The elimination of Na is peculiar because it is practically unchanged, whereas the nitrogen-containing components behave all similar to the other ones, that is, they are increased. It should be emphasized that the xanthine bases are eliminated twice as much [as prior to the crisis], whereas the former is eliminated four times as much. The eliminated amount surpasses by far the amount observed on fever days; also the loss in nitrogen and phosphorus, calculated from the balance, is at a maximum on the day of the crisis. When the ratio of the eliminated compounds with respect to N is calculated (Table VI), P is again at the top; in fact, the other urine components behave, at times differently. For instance, chlorine, potassium, sodium, calcium, et cetera are decreased with respect to nitrogen in spite of the fact that the hourly elimination increased significantly. As is seen from Table VI, sodium, chlorine, calcium, potassium, urea, and uric acid are decreased with respect to nitrogen (sodium the most), whereas phosphorus, xanthine bases, and ammonia are increased.

So much for the characterization of the crisis. As far as the post-febrile period is concerned, each increase in body temperature is accompanied by a decrease in nitrogen and phosphorus elimination, whereas the potassium and uric acid elimination increases. Chlorine, calcium, and sodium behave like nitrogen; consequently, they decrease when the body temperature increases.

The reverse takes place when the body temperature drops. The nitrogen elimination is increased and so are the phosphorus and ammonia eliminations. The greatest losses in nitrogen and phosphorus occur during this period, as is seen from the balance. Chlorine behaves irregularly; often, it increases during the afebrile days. However, subsequently it drops to such values which have never been observed at the climax of the fever. It follows from the balance that retention in the body is greatest after the remission and that it gradually decreases. The sodium and calcium balances behave in the same manner. On the other hand, the loss in phosphorus increases after remission and this P-loss increases further after the fever, until it begins to recede after three to four days. The potassium salts are lost by the body, to the slightest extent immediately after the fever, subsequently more distinctly.

Approximately the same follows from an analysis of the Table of the hourly elimination; only in this case the dependence on the course of the fever is more distinct.

It is still more distinct in Table VI, where the hourly elimination is calculated with respect to nitrogen. The behavior of phosphorus exhibits the greatest regularity, chlorine is vague and so are the potassium and sodium salts.

It cannot be denied that chlorine, calcium, and potassium behave quite differently than in the typhus cases, and this may be the reason for the large difference in the results of the fever studies.

Case IV. H.K., 19 years of age. *Febris intermittens quotidianas*.

Case history: patient's father died of cholera, the mother is sickly. Three brothers and sisters died when they were young. The patient comes from Hamburg, spent some time in Italy where he got sick with fever and headaches. He left Italy and went to Switzerland. During the journey by foot, he suffered from fever chills which he had not had previously during the fever attacks in Italy.

Present state: nothing detectable at the organs, except for a slight enlargement of the spleen. Hemoglobin content 60 percent, [red] blood count 4,120,000.

The diet consisted of milk and broth and consisted per day of

| | |
|------------|------------|
| 10.340 g N | 6.246 g Cl |
| 1.260 g P | 1.740 g Ca |
| 2.748 g K | 3.562 g Na |

The urine was collected in five portions. The first portion comprised the time period prior to the fever 10 AM to 2:30 PM. Temperature 36.4°C, pulsation 92. Amount of urine 125 cc.

The second portion comprised the time of the fever chills 2:30 PM to 4 PM. Temperature 41.0°C, pulsation 106. Amount of urine 235 cc.

The third portion comprised the time period of the climax of the fever 4 PM to 7 PM. Temperature 40.2°C, pulsation 96. Amount of urine 295 cc.

The fourth portion comprised the time period after the fever attack 7 PM to 6 AM. Temperature 39.9, 38.6, 37.5°C, pulsation 108, 104, 96. Amount of urine 325 cc.

The fifth and last portion comprised the period of normal temperature from 6 AM to 10 AM. Temperature 36.3°C, pulsation 80. Amount of urine 185 [cc].

The patient eliminated 1165 cc urine in which:

| | |
|----------|-------------------|
| N 15.792 | balance N - 5.452 |
| Cl 4.934 | Cl + 1.312 |
| P 0.917 | P + 0.343 |
| Ca 0.263 | Ca + 1.477 |
| K 2.665 | K + 0.083 |
| Na 2.739 | Na + 0.823 |

The food contained the above-mentioned amounts. Thus, the balance showed, as will be found on the subsequent Table, a loss for nitrogen. All other components were retained, a correction must be made for this because the feces were not considered. This concerns mainly P, Ca, K. If one remembers the known numbers, a slight loss in P and potassium may be assumed, whereas calcium, sodium, and chlorine remain probably unchanged.

In the food the ratio to the nitrogen is as follows:

| N: | Cl: | P: | Ca: | K: | Na: | |
|----|-------|-------|-------|-------|-------|--------------|
| 1: | 0.62 | 0.12 | 0.17 | 0.27 | 0.35 | in the food |
| 1: | 0.312 | 0.058 | 0.016 | 0.161 | 0.165 | in the feces |

Compared to nitrogen, all components are eliminated to a lesser extent.

The hourly elimination is given in Table VII.

Table VII. Malaria Fever

| Time | Temp. and Pulsation | Percent | Amt of Urine | Spec. Wt. | Total Elimination | Per hour Gram | Time |
|------|---------------------|---|--------------|-----------|--|--|--|
| I. | 36.4 92 | 1.6205 0.2912 0.0891 0.0484 0.1522 0.1377 | 125 cc | 1.022 | N 2.025 Cl 0.364 P 0.111 Ca 0.061 K 0.190 Na 0.172 | 0.455 0.081 0.025 0.014 0.042 0.038 | 10 AM until 2:30 PM; 4.5 hours; amount of urine per hour 27.7 cc |
| II. | 41.0 106 | 0.7875 0.6371 0.0162 0.0171 0.2390 0.3676 0.0259 | 235 cc | 1.018 | N 1.8485 Cl 1.4969 P 0.0376 Ca 0.0399 K 0.5497 Na 0.8454 NH ₃ 0.0596 | 1.2325 0.9969 0.0251 0.0266 0.3665 0.5636 0.0397 | 2:30 PM until 4 PM; 1.5 hours; amount of urine per hour 94 cc |
| III. | 40.0 92 | 9.183 0.4854 0.0043 0.0252 0.1884 0.2584 0.0105 0.0109 0.0004 0.0266 | 295 cc | 1.019 | N 3.481 Cl 1.416 F 0.0127 Ca 0.0737 K 0.5546 Na 0.7611 uric acid 0.0309 alloxuric bases 0.0321 xanthine bases 0.0018 NH ₃ 0.0784 | 1.160 0.472 0.0042 0.0246 0.1849 0.2574 0.0103 0.0107 0.0004 0.0261 | 4 PM until 7 PM; 3 hours; amount of urine per hour 95 cc |

| Time | Temp. and Pulsa- tion | Percent | Amt of Urine | Spec. Wt. | Total Elimination | Per hour Gram | Time |
|------|--|--|-----------------|--------------|--|--|--|
| IV. | 39.9 38.6 37.5 108 104 97 | 1.645 0.3034 0.1458 0.0142 0.2916 0.1798 1.120 0.0245 0.0249 | 325 cc | 1.024 | N 5.3302 Cl 0.9847 P 0.4747 Ca 0.0455 K 0.9457 Na 0.5854 urea 3.640 uric acid 0.0796 alloxuric bases 0.0809 xanthine bases 0.0013 NH ₃ 0.1810 | 0.4845 0.0895 0.0432 0.0041 0.0859 0.0532 0.3310 0.0072 | 7 PM until 6 AM; 11 hours; amount of urine per hour 29.5 cc |
| V. | 36.3 80 | 0.0004 0.0560 1.687 0.3641 0.0512 0.9234 0.2208 0.2032 0.624 | 185 cc | 1.025 | M 3.1080 Cl 0.6734 F 0.2817 Ca 0.0433 K 0.4255 Na 0.3759 urea 2.997 | 0.0073 0.0001 0.0165 0.7770 0.1683 0.0704 0.0108 0.1064 0.0940 0.7490 | 6 AM until 10 AM; 4 hours; amount of urine per hour 45.2 cc |

| Temp. | $\frac{\text{Cl}}{\text{N}}$ | $\frac{\text{P}}{\text{N}}$ | $\frac{\text{Ca}}{\text{N}}$ | $\frac{\text{K}}{\text{N}}$ | $\frac{\text{Na}}{\text{N}}$ | $\frac{\text{urea}}{\text{N}}$ | $\frac{\text{NH}_3}{\text{N}}$ | $\frac{\text{uric acid}}{\text{N}}$ | $\frac{\text{allox bases}}{\text{N}}$ |
|-------|------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|--------------------------------|--------------------------------|-------------------------------------|---------------------------------------|
| 36.4 | 0.178 | 0.056 | 0.0307 | 0.092 | 0.083 | - | - | - | - |
| 41.0 | 0.809 | 0.020 | 0.0215 | 0.297 | 0.457 | 0.996 | 0.032 | - | - |
| 40.0 | 0.407 | 0.003 | 0.0212 | 0.159 | 0.218 | - | 0.0224 | 0.009 | 0.009 |
| 38.6 | 0.184 | 0.089 | 0.0084 | 0.117 | 0.109 | 0.660 | 0.034 | 0.014 | 0.005 |
| 36.3 | 0.215 | 0.091 | 0.0139 | 0.137 | 0.121 | - | - | - | - |

The results of this study do not present much new information so that it is hardly necessary to discuss them. What has been found by Limbeck, Terray, Hitzig, and others has been confirmed [here].

The elimination of nitrogen rose and declines with the temperature -- however, only when taken absolutely. Relative to the water elimination, the nitrogen elimination was decreased during the fever, as may be seen from the percentage of nitrogen.

The chlorine elimination increased during the fever quite significantly when taken relatively, as well as when taken absolutely; it decreased immediately after the remission of the fever and increased during apyrexia.

On the other hand, the phosphorus elimination dropped during the fever and reached its maximum in the post-febrile period. The elimination of P was normal in the post-febrile period.

The elimination of potassium salts was completely analogous to that of chlorine, even if relative to the water elimination, at the onset of the fever, a drop could be observed which lasted during the fever.

Potassium salts take up a special position, as usual. Relative to the water elimination, they attain their maximum in the post-febrile period. Taken absolutely, they follow chlorine and have their minimum in the post-febrile period. The sodium salts are to be compared to chlorine in all aspects.

The elimination of nitrogen-containing substances could not be determined in all cases because of lack of material. It is therefore difficult to state anything about its course. It seems as if the elimination of uric acid and xanthine bases increased relatively with respect to water and N elimination after the fever, even if the absolute amount per hour is lower in the post-febrile period.

In comparing the hourly amount eliminated with nitrogen, the above-stated facts become even more pronounced.

The daily elimination in comparison with the food consumption exhibits the course typical during the fever; a relatively diminished chlorine, calcium, and sodium elimination, and an increased nitrogen, phosphorus, and potassium elimination.

Case V. B.K., 49 years of age. Phtisis pulmonum Febris hectica.

Case history: father, brothers, and sisters are healthy, mother suffered supposedly from cough. The (female) patient had gonitis. She got married and had two children who died both in their childhood. The present suffering started a few months ago and resulted in a general weakness.

Present state: patient exhibits in both lungs the phenomena of a decomposing infiltration; she expectorates a lot. The other organs do not exhibit any abnormalities. Patient has hectic typhus. The difference in body temperature amounts to 2.5°C.

The patient was given the same diet for several days. This diet consisted of milk and broth. The urine was analyzed on two days; no differences were observed. The daily elimination was collected in four portions of which

the first portion was collected from 12 noon to 4 PM, corresponding to the prae-febrile period. The body temperature was 37.0, pulsation 100;

the second portion was collected in the febrile period from 4 PM to 10 PM. Temperature 38.0 to 39.0;

the third period corresponds to the remission from 10 PM to 6 AM. Temperature 37.0;

the fourth and final period lasted from 6 AM to 12 noon and corresponded to the apyrexia. Temperature 36.0, pulsation 90.

Also in this case, the feces were not examined; however, this does not affect the problem under consideration. The results were:

| Elimination | Food | Balance |
|-------------|--------|----------------|
| 5.6006 N | 10.340 | +4.7394 gram N |
| 3.7664 Cl | 6.246 | +2.4796 - Cl |
| 0.2749 P | 1.260 | +0.9851 - P |
| 0.0952 Ca | 1.740 | +1.6448 - Ca |
| 1.0642 K | 2.748 | +1.6840 - K |
| 1.1028 Na | 3.562 | +2.4592 - Na |

The ratio of N to Cl, P, Ca, K, Na in the food was:

| | | | | | | |
|---------------------|----|------|------|-------|------|------|
| | N: | Cl: | P: | Ca: | K: | Na: |
| | 1: | 0.62 | 0.12 | 0.17 | 0.27 | 0.35 |
| in the elimination: | 1: | 0.67 | 0.04 | 0.016 | 0.19 | 0.20 |

The difference concerns Ca and P; both are ample in the feces. We may assume that no special retention takes place, only a general apathy, an insufficient assimilation.

Table IX

| Time | Temp. and Pulsa- tion | Amt of Urine | Spec. wt. | Percent | Total Elimina- tion | Per hour Gram | Water Per hour |
|--------------------------------|-----------------------------|-----------------|--------------|--|--|--|-------------------|
| 12 noon to 4 PM; 4 hours | 37° 100 | 400 cc | 1.006 | N 0.217 Cl 0.1214 P 0.0235 Ca 0.0049 K 0.0401 Na 0.0515 urea 0.196 alloxuric bases 0.0075 NH ₃ 0.0056 | 0.9548 0.5342 0.1034 0.0215 0.1764 0.2860 0.8624 | 0.2387 0.1335 0.0259 0.0054 0.0441 0.0715 0.2156 | I. 110 cc |
| 4 PM to 10 PM; 6 hours | 38-39 106 | 460 cc | 1.010 | N 0.378 Cl 0.315 P 0.0290 Ca 0.0068 K 0.0629 Na 0.0852 urea 0.341 uric acid 0.3077 alloxuric bases 0.0109 xanthine bases 0.0032 NH ₃ 0.0119 | 0.7388 1.4490 0.1335 0.0312 0.2893 0.3919 0.5686 0.0354 | 0.2898 0.2415 0.0223 0.0052 0.0482 0.0653 0.2614 0.0060 | II. 76.6 cc |
| 10 PM to 6 AM; 8 hours | 37.1 100 | 450 cc | 1.005 | N 0.392 Cl 0.2669 P 0.0160 Ca 0.0078 K 0.0829 Na 0.0590 urea 0.322 | 1.764 1.201 0.072 0.0351 0.3731 0.2655 1.449 | 0.2205 0.1501 0.0090 0.0043 0.0441 0.0332 0.1811 | III. 56 cc |

| Time | Temp. and Pulsa- tion | Amt of Urine | Spec. Wt. | Percent | Total Elimina- tion | Per hour Gram | Water Per hour |
|--------------------------------|-----------------------------|-----------------|--------------|---|--|---|-------------------|
| 6 AM to 12 noon; 6 hours | 36.0 | 240 cc | 1.011 | uric acid 0.0081 alloxuric bases 0.0116 xanthine bases 0.0035 NH ₃ 0.0097 N 0.476 Cl 0.2427 P 0.0275 Ca 0.0031 K 0.0939 Na 0.664 NH ₃ 0.0084 | 0.0365 0.0522 0.0158 0.0437 1.1424 0.5822 0.0660 0.0074 0.2254 0.1594 0.0202 | 0.0046 0.0063 0.0019 0.0055 0.1904 0.0970 0.0110 0.0012 0.0376 0.0266 0.0033 | IV. 40 cc |
| 12 noon to 4 PM; 4 hours | 37.0 90 | 280 cc | - | Second Day N 0.385 Cl 0.255 P 0.038 uric acid 0.0081 alloxuric bases 0.0115 xanthine bases 0.0037 NH ₃ 0.0105 N 0.518 Cl 0.2851 P 0.035 uric acid 0.0103 alloxuric bases 0.0109 | 1.0780 0.7140 0.1064 0.0225 0.0329 0.0104 0.0294 1.8648 1.0260 0.1260 0.0371 0.0392 | 0.269 0.179 0.0266 0.0056 0.0092 0.0026 0.0074 0.3108 0.1710 6.021 0.0062 0.0065 | I. 70 cc |
| 4 PM to 10 PM; 6 hours | 39.0 | 360 cc | - | | | | |

| Time | Temp. and Pulsa- tion | Amt of Urine | Spec. Wt. | Percent | Total Elimina- tion | Per hour Gram | Water Per hour |
|--------------------------------|--------------------------------|-----------------|--------------|--|---|---|-------------------|
| 10 PM to 6 AM 8 hours | 38° | 250 cc | - | xanthine bases 0.0006 NH_3 0.0133 H 0.5145 Cl 0.2548 P 0.0320 uric acid 0.0116 alloxuric bases 0.0126 xanthine bases 0.0010 NH_3 0.0168 | 0.0022 0.0479 1.286 0.637 0.080 0.0290 0.0395 0.0025 0.0420 | 0.0003 0.0080 0.161 0.079 0.010 0.0036 0.0039 0.0003 0.0052 | III. 31 cc |
| 6 AM to 12 noon; 6 hours | 36 | 50 cc | - | N 0.2366 Cl 0.0131 uric acid 0.0131 alloxuric bases 0.0205 xanthine bases 0.0073 | 0.1183 0.0065 0.0102 0.0036 | - 0.0197 0.0011 0.0017 0.0006 | IV. 9 cc |

Table X

| Temp. | Cl N | P N | Ca N | K N | Na N | urea N | uric acid N | allox. bases N | NH ₃ N |
|-------|---------|--------|---------|--------|---------|-----------|-------------------|----------------------|----------------------|
| 37°a | 0.557 | 0.109 | 0.022 | 0.180 | 0.299 | 0.903 | - | 0.041 | 0.025 |
| b | 0.667 | 0.100 | - | - | - | - | 0.021 | 0.030 | 0.027 |
| 39°a | 0.833 | 0.077 | 0.014 | 0.164 | 0.285 | 0.902 | 0.021 | 0.029 | 0.029 |
| b | 0.557 | 0.069 | - | - | - | - | 0.019 | 0.021 | 0.025 |
| 38°a | 0.681 | 0.041 | 0.020 | 0.200 | 0.151 | 0.823 | 0.021 | 0.029 | 0.025 |
| b | 0.494 | 0.062 | - | - | - | - | 0.022 | 0.024 | - |
| 36°a | 0.510 | 0.058 | 0.006 | 0.197 | 0.140 | - | - | - | 0.030 |

The results of the observation of elimination during hectic fever confirm the results observed in the malaria case. Also in this case, the chlorine elimination is lower during the febrile period than during the afebrile period. The minimum is found during the apyrexia. The phosphorus elimination drops with increasing body temperature, reaches a minimum during the post-febrile period, and subsequently increases during the period of the apyrexia up to the prae-febrile period during which it reaches its maximum.

Calcium drops with the onset of the fever, decreases somewhat more, and drops to its minimum in the prae-febrile period.

Strangely enough, sodium does not behave in parallel with chlorine. It drops at the climax of the fever, subsequently it drops still more, does not reach the minimum in the post-febrile period (in agreement with chlorine), and has its maximum in the prae-febrile period. Potassium increases with the fever, drops steadily up to the apyrexia during which it reaches its minimum, whereas the maximum occurs at the climax of the fever. Urea is eliminated to the largest degree at the climax of the fever; the alloxuric bases have their minimum in the prae-febrile period, whereas their maximum occurs during the apyrexia.

Ammonia, like chlorine, is eliminated to a larger extent at the climax of the fever; subsequently it drops, reaches its minimum during the apyrexia, and ascends in the prae-febrile period.

When the elimination is compared with nitrogen, it appears to be somewhat different, but no essential differences are noticed. Thus, chlorine has its maximum at the climax of the fever, its minimum during the apyrexia; phosphorus has its maximum during the prae-febrile period, its minimum during the post-febrile period. Calcium has its minimum during the apyrexia, its maximum during the prae-febrile period. Potassium has its minimum at the climax of the fever, its maximum during the post-febrile period. Sodium reaches its minimum during the apyrexia, its maximum during the prae-febrile period. The alloxuric bases are eliminated most during the prae-febrile period, least during the apyrexia. Ammonia behaves exactly in the reverse way.

The rise in body temperature is accompanied by an increase in chlorine and ammonia, and by a decrease in all other components. The drop in body

temperature is accompanied by an increase in phosphorus and nitrogen, and by a decrease in all other components. Calcium, sodium, and potassium exhibited an increase only in the second fever period.

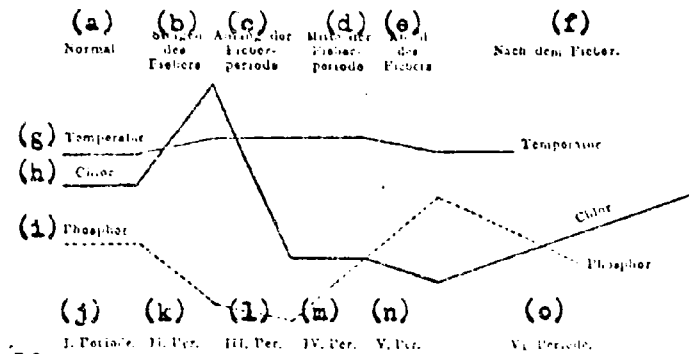
The study of the elimination in the various types of fevers has shown with certainty only one thing: elimination during remission may possess the characteristics of an elimination during a fever in a pronounced way. Elimination during rise of the fever can exhibit the same characteristics to a lesser extent.

When I am talking about elimination during the fever, I mean the known retention of chlorine and the increase in phosphorus and nitrogen. This can also occur during remission and can disappear when the fever increases.

In more detail, this means that after the drop in body temperature, chlorine is especially retained, and phosphorus and nitrogen are being especially [strongly] eliminated. If another increase in body temperature follows, chlorine is increased, although it should be retained; phosphorus is eliminated in smaller quantities instead of in increased quantities.

It appears that the body reacts differently at the onset and at the end of the fever than during the fever. In the long run, the fever causes the known changes; if, however, a temperature increase occurs also during the fever, then a situation arises which corresponds to the convalescence period (the afebrile period). If a decrease in body temperature takes place, increased fever phenomena occur. Rise and drop in body temperature shall be a measure for the fever. The question why this is justified, will not be discussed here.

Therefore, when we wish to devise a scheme according to what has been said, it will be of the following form: the first rise in temperature results in an increase in chlorine (I will omit sodium, potassium, calcium, and ammonia as not to complicate the discussion), in a decrease of nitrogen (or in an increase), and in a diminishing of phosphorus. When the fever persists unchanged, the second period exhibits a gradual decrease in chlorine elimination, an increase in nitrogen (or nitrogen stays at the previous height), a decrease in phosphorus. The third period -- still at the same temperature -- exhibits a decrease in chlorine, and an increase in phosphorus and nitrogen; to be sure, chlorine has dropped below normal, and phosphorus and nitrogen have risen above normal. At this point, we have the type of elimination which is known as fever urine. This situation may last when the body temperature remains unchanged. When the body temperature drops (perhaps due to dilution of the blood), the fourth stage sets in: chlorine is retained still more, phosphorus and nitrogen are eliminated still more strongly. When the drop in temperature lasts, chlorine attains its minimum, phosphorus and nitrogen attain their maximum, and the situation changes gradually. The fifth stage begins, the chlorine elimination rises up to normal, P and N recede to normal.



Key to Figure: a--Normal; b--rise of fever; c--onset of fever period; d--middle of fever period; e--remission; f--after the fever; g--temperature; h--chlorine; i--phosphorus; j-- I. period; k--II period; l--III period; m--IV period; n--V period; o--VI period.

This would be the situation of the fever as it occurs in malaria and as we have found it in other types of fever.

If an explanation is attempted, it must be presupposed that the blood vessels are the ones, or rather that it is the blood which undergoes the same changes as the urine. The blood contains more water and chlorine than the tissues, but it contains less phosphorus and nitrogen.

Thus, when we find the urine to be enriched in chlorine and poor in phosphorus at the onset of the fever (I period), then this implies that the flow from the tissues into the blood is interrupted; the blood supplies a small amount of water and a small amount of sodium chloride to the tissues, it takes up a small amount of phosphorus and a small amount of nitrogen. This corresponds to a circulation which makes the diffusion flow little effective either by narrowing of the vessels or by slowing down the blood flow.

This type of circulation does not last long; it is followed by a stage of enlargement of the vessels and fast circulation. The II and III stage occur. The blood which is richer in water supplies its water and sodium chloride to the organs; it retains the externally added water and carries the nitrogen-containing substances along. The decomposition of the nitrogen-containing substances occurs within a short period of time, the phosphorus-containing substances are more stable. For this reason, the minimum of phosphorus occurs at this point and the N in the urine increases at a faster rate than the phosphorus. Thus, we are at the climax of the fever and the decomposing large albumin molecule yields increasingly more substances. The small molecule of the latter increases the osmotic pressure

and water and salts* are increasingly retained. The albumin decomposition is, therefore, caused and maintained by the increase in water content of the body. When the fever starts to recede, that is, when the circulation is improved and the organs give off water, the fever phenomena are enhanced; the flow is reversed and the water with its salts is transferred from the organs into the blood instead of from the blood to the organs; the salts are poor in chlorine and rich in phosphorus. The elimination of water is increased, however the elimination of sodium chloride is not increased; phosphorus salts and nitrogen are eliminated with the water until the equilibrium is being reestablished and everything goes back to normal. If we imagine during the remission stage a sudden increase in the body temperature then the phosphorus elimination is inhibited due to the disturbance in the circulation, [and] the chlorine is increased; the reverse takes place when we think of a drop in temperature during the fever.

It is seen from the studies by Rosenthal (23), E. Aronsohn (24), Geigel (25), Maragliano (26) that a decrease in heat evolution (contraction of the vessels) takes place in acute fever cases when the body temperature increases (Rosenthal); [it is also found] that after the temperature remission and during the remission, the volume of the vessels increases (plethysmograph -- experiments by Maragliano).

The increased nitrogen elimination in the stage of the latent fever period, which has been observed by Naunyn, does not contradict the above-stated facts; because firstly, we observed also an increase in N with temperature, and secondly, the experiments of Naunyn involve dogs who had been subcutaneously injected with sanies; thus, the fever started with the decomposition in the blood, as it is also the case with malaria.

Röhmman's explanation of the chlorine retention by the tissue albumin still holds. I have expressed a similar opinion when I studied the metabolism in anaemia cases; however, I believe that, even without this assumption, there are enough reasons for the chlorine retention.

Von Terray explained the increased chlorine elimination with the decomposition of the blood corpuscles. The blood corpuscles contain such a small amount of chlorine that they would all have to decompose to provide the necessary amount. When, however, a chronic decomposition of blood corpuscles takes place, the chlorine is by no means increased; on the contrary, it is decreased, as it is the case with all chronic anaemias.

There are also theories about the post-febrile nitrogen elimination. For instance, Naunyn and others believe that the increased N-elimination is due to an accumulation of nitrogen in the body. The kidneys are overloaded with decomposition products and give off the entire load at once. This opinion would be difficult to contradict, were it not for the fact that in

* Cf. E. Schulze, Zeitschrift für physikalische Chemie Vol 23, page 18.
"On the metabolism of albumens in the living plant"

the post-febrile period a decrease in chlorine elimination is observed in addition to the accumulation of nitrogen. This leads us to believe that a change in the circulation is the cause of all phenomena. After the fever, the exchange between the tissues and the blood corpuscles must become more vigorous; this way, an elimination occurs which represents a more acute picture of the fever elimination.

This post-febrile and prae-febrile change in the vessels has a special effect, particularly on soluble salts; only sodium and potassium salts -- probably the soluble chlorides -- exhibit the peculiarity of a swift rise, as well as that of a rapid drop. Calcium phosphate does not follow the fluctuations as rapidly, and its typical behavior remains: it decreases with a temperature increase and it increases with a temperature drop. Phosphorus and ammonium salts belong also to the sluggish substances. The phosphorus elimination must be preceded by a nucleic acid decomposition. For this reason, phosphorus reaches its maximum only in the second stage and lasts longer than the fever. The formation of the ammonium salts requires and "acidification"* of the fluids. Therefore, ammonia behaves similar to phosphorus.

Potassium exhibits, no doubt, the most peculiar behavior, and when we explain the increased elimination during the temperature rise with the fast diffusion, there remains no explanation whatsoever for the drop in the post-febrile period which, by the way, is not a rule, except that we would have to assume that potassium obeys here the same laws as those obeyed by sodium.

The explanation, whether elegant or not, is not the essential point of concern and it does not change anything in the observations. In the old studies of Langley and Huppert we have found figures which had been neglected or which had been considered useless by them, [and] which become even more significant in view of our explanation. We hope that we have been able to supply with our observations reliable data also for other theories.

* "Acidification", in the sense used previously, caused by a decrease in the alkalinity which decrease coincides with the increase in ammonia.

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